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# Are unhealthy freshwater ecosystems bad for us?

## Is the apocalypse coming asks Dr Death

Russell Death[1], Meredith Davis[1] & Alison Dewes[2]
[1]River Science Massey University & [2]Tipu Whenua

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# Its not easy giving public talks as a river ecologist ☹

Highest percentage of endangered freshwater fish species in the world ☹

Most polluted river in the Western world ☹

Giving water (from National Parks) to bottling companies to sell :-(


No monitoring of any endangered freshwater invertebrates ☹

Increasing nitrate levels in our waterways ☹

Highest level of some waterborne diseases in the world ☹

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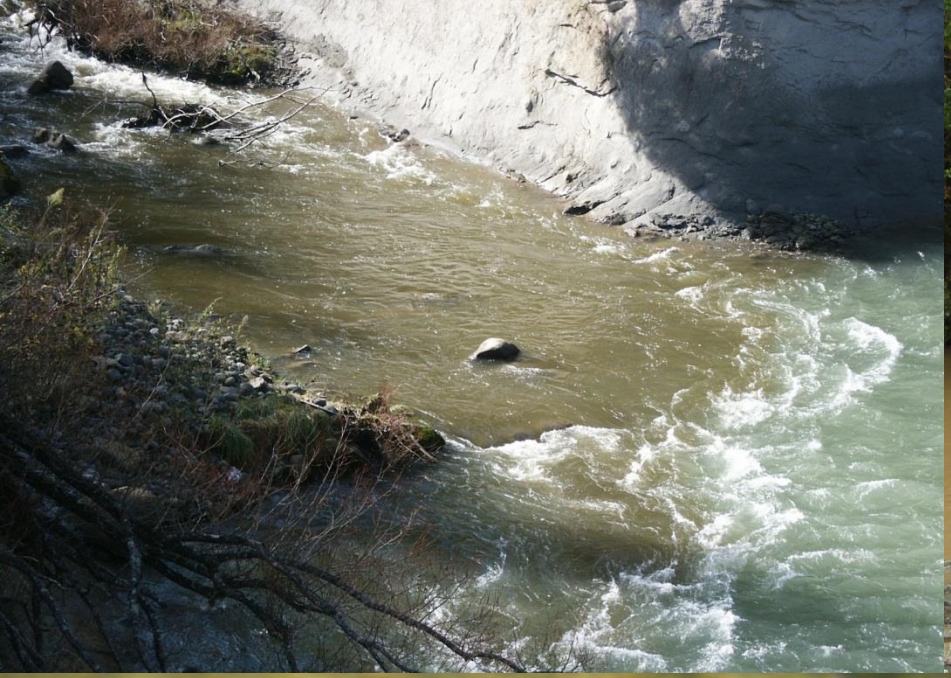
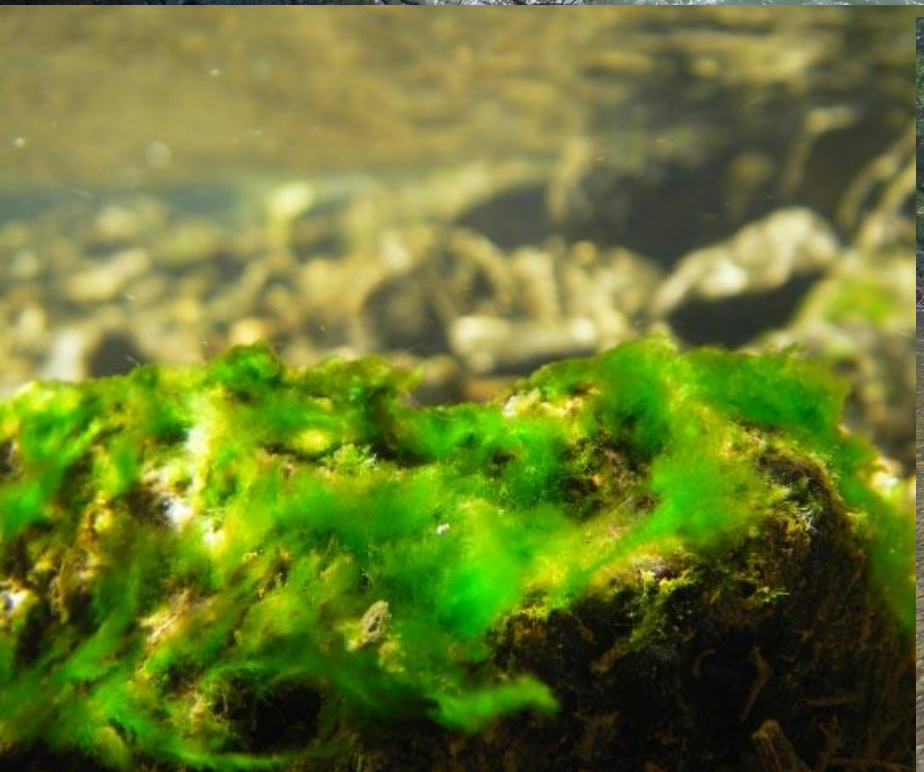
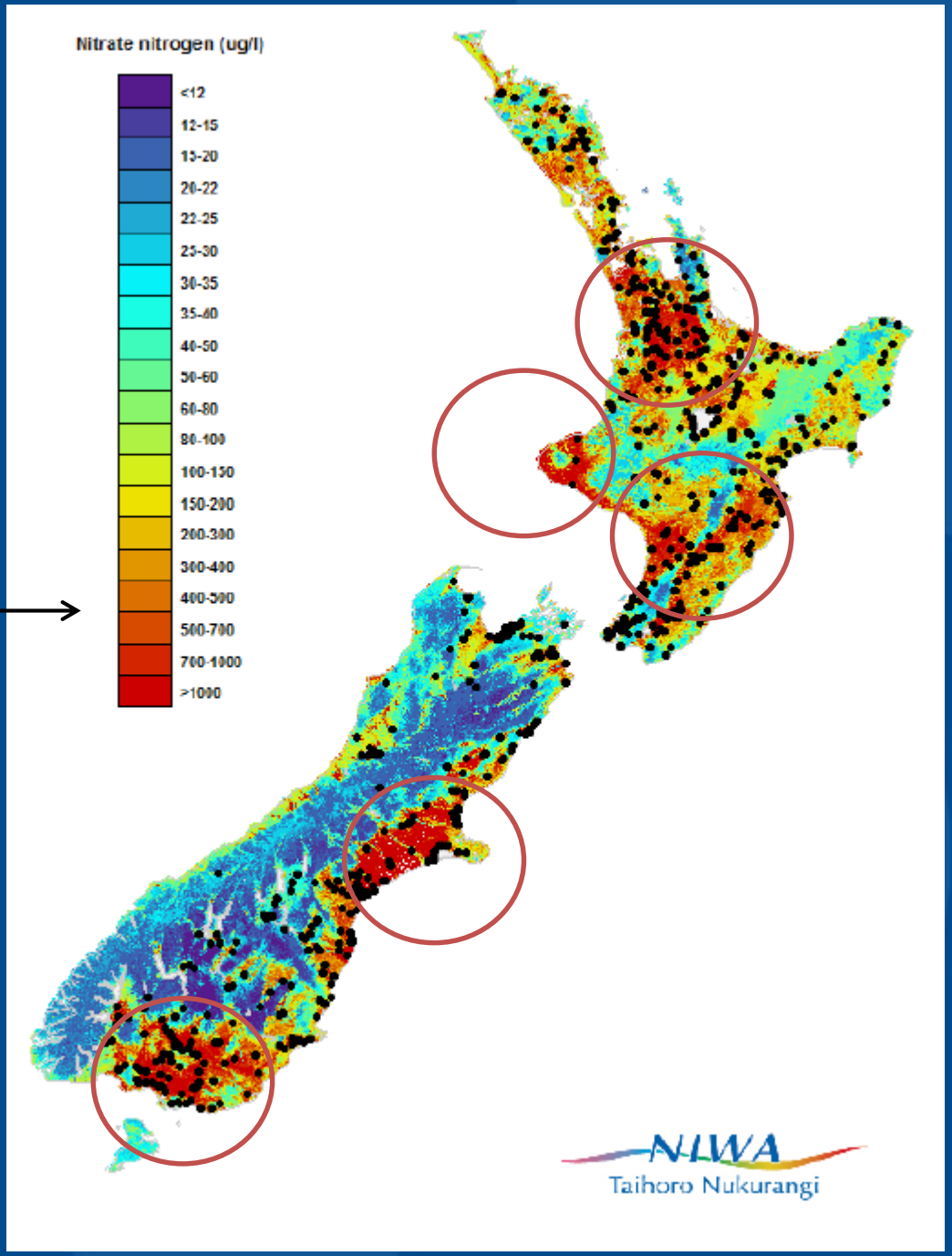




Is water quality declining in New Zealand?

ANZECC trigger level




Nitrate

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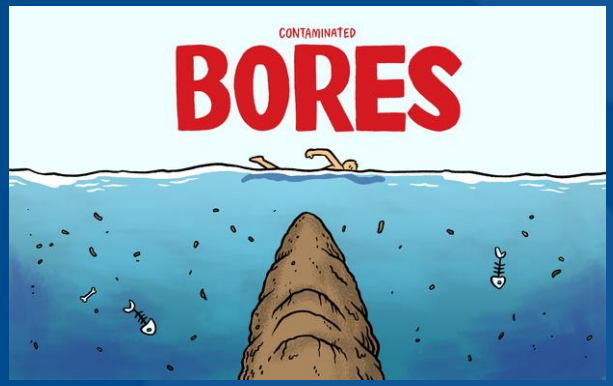
# Unprecedented public concern about our waterways





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# Three reports this year say – water quality is “declining”



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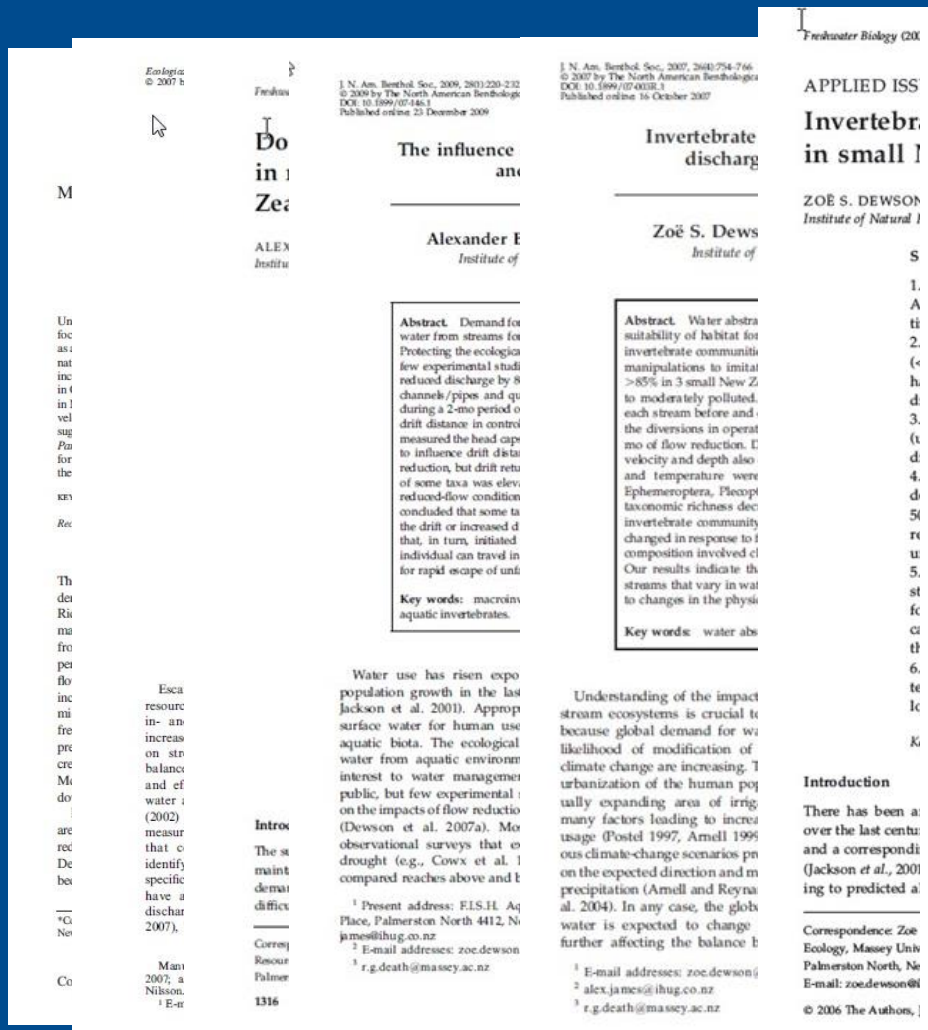
# Not to mention 20 + years of science research



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Hydrology and Earth System Sciences
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## River water quality changes in New Zealand over 26 years: response to land use intensity

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[2]Department of Geography and Environmental Sustainability, The University of Oklahoma, Norman, OK, USA
[3]National Institute of Water and Atmospheric Research (NIWA), Hamilton, New Zealand
[4]Landcare Research, Palmerston North, New Zealand
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Received: 25 June 2016 – Discussion started: 21 July 2016
Revised: 22 January 2017 – Accepted: 25 January 2017 – Published: 23 February 2017

**Abstract.** Relationships between land use and water quality are complex with interdependencies, feedbacks, and legacy effects. Most river water quality studies have assessed catchment land use as areal coverage, but here, we hypothesize and test whether land use *intensity* – the inputs (fertilizer, livestock) and activities (vegetation removal) of land use – is a better predictor of environmental impact. We use New Zealand (NZ) as a case study because it has had one of the highest rates of agricultural land intensification globally over recent decades. We interpreted water quality state and trends for the 26 years from 1989 to 2014 in the National Rivers Water Quality Network (NRWQN) – consisting of 77 sites on 35 mostly large river systems. To characterize land use intensity, we analyzed spatial and temporal changes in livestock density and land disturbance (i.e., bare soil resulting from vegetation loss by either grazing or forest harvesting) at the catchment scale, as well as fertilizer inputs at the national scale. Using simple multivariate statistical analyses across the 77 catchments, we found that median visual water clarity was best predicted inversely by areal coverage of intensively managed pastures. The primary predictor for all four nutrient variables (TN, $NO_x$, TP, DRP), however, was cattle density, with plantation forest coverage as the secondary predictor variable. While land disturbance was not itself a strong predictor of water quality, it did help explain outliers of land use–water quality relationships. From 1990 to 2014, visual clarity significantly improved in 35 out of 77 (34/77) catchments, which we attribute mainly to increased dairy cattle exclusion from rivers (despite dairy expansion) and the considerable decrease in sheep numbers across the NZ landscape, from 58 million sheep in 1990 to 31 million in 2012. Nutrient concentrations increased in many of NZ's rivers with dissolved oxidized nitrogen significantly increasing in 27/77 catchments, which we largely attribute to increased cattle density and legacy nutrients that have built up on intensively managed grasslands and plantation forests since the 1950s and are slowly leaking to the rivers. Despite recent improvements in water quality for some NZ rivers, these legacy nutrients and continued agricultural intensification are expected to pose broad-scale environmental problems for decades to come.

### 1 Introduction

River water quality reflects multiple activities and processes within its catchment, including geomorphic processes, vegetation characteristics, climate, and anthropogenic land uses (Brierley, 2010). Relationships between water quality and these catchment characteristics are not straightforward because all of these factors interact over both space and time. For example, if intensive livestock grazing occurs on steep slopes, surface runoff and consequently river turbidity is expected to be greater than if grazing occurs on flatter areas; in other respects, if fertilizers are heavily applied to sandy soils with high drainage density, rivers will likely become

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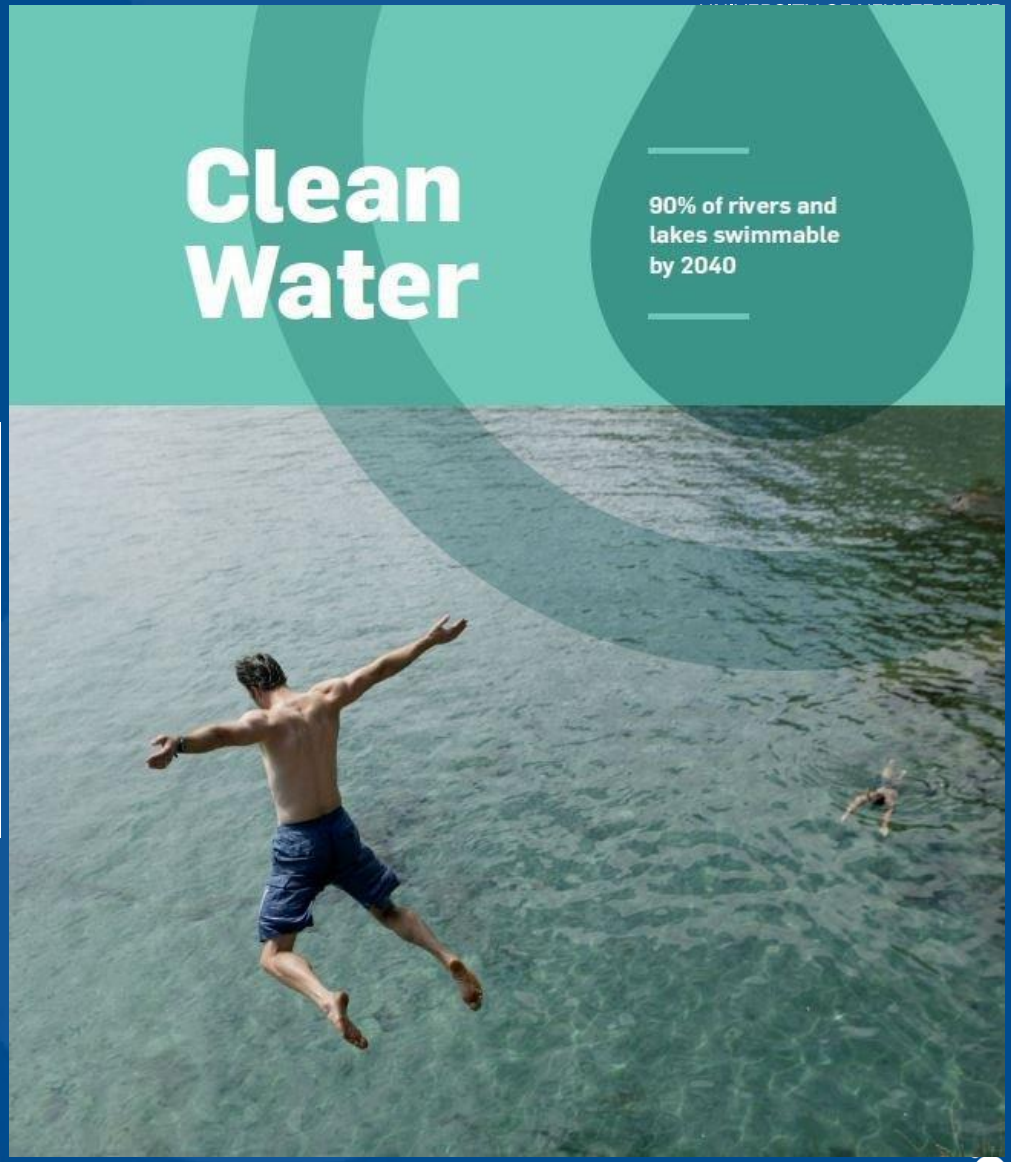
*Just as dirty as before* Water reforms 2017

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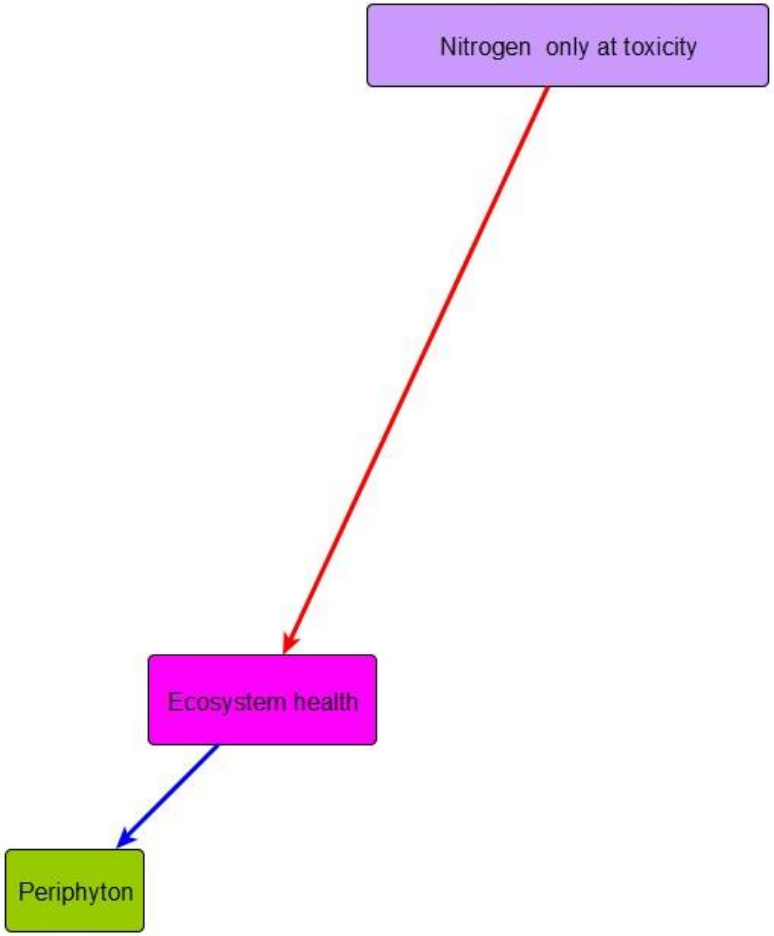
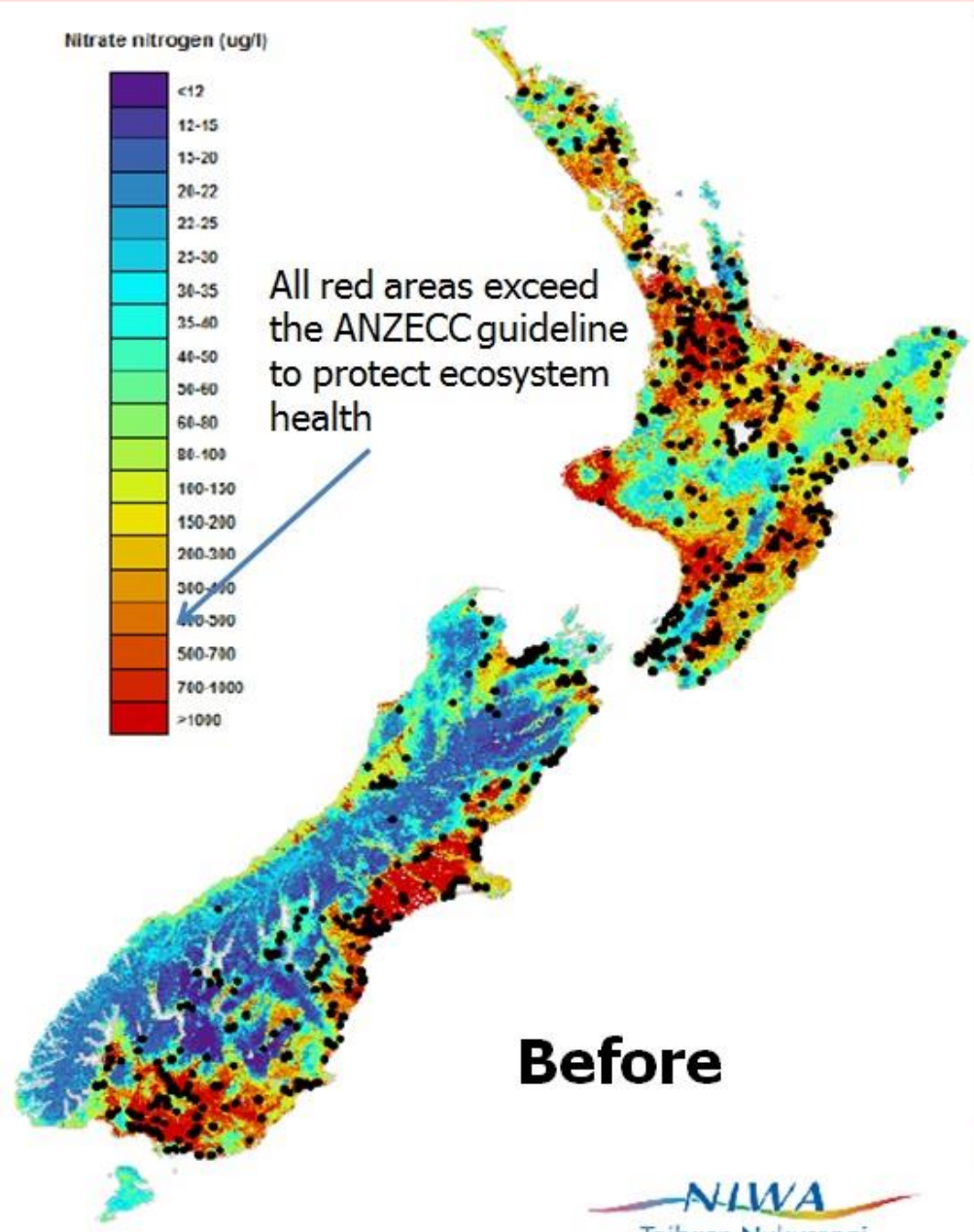
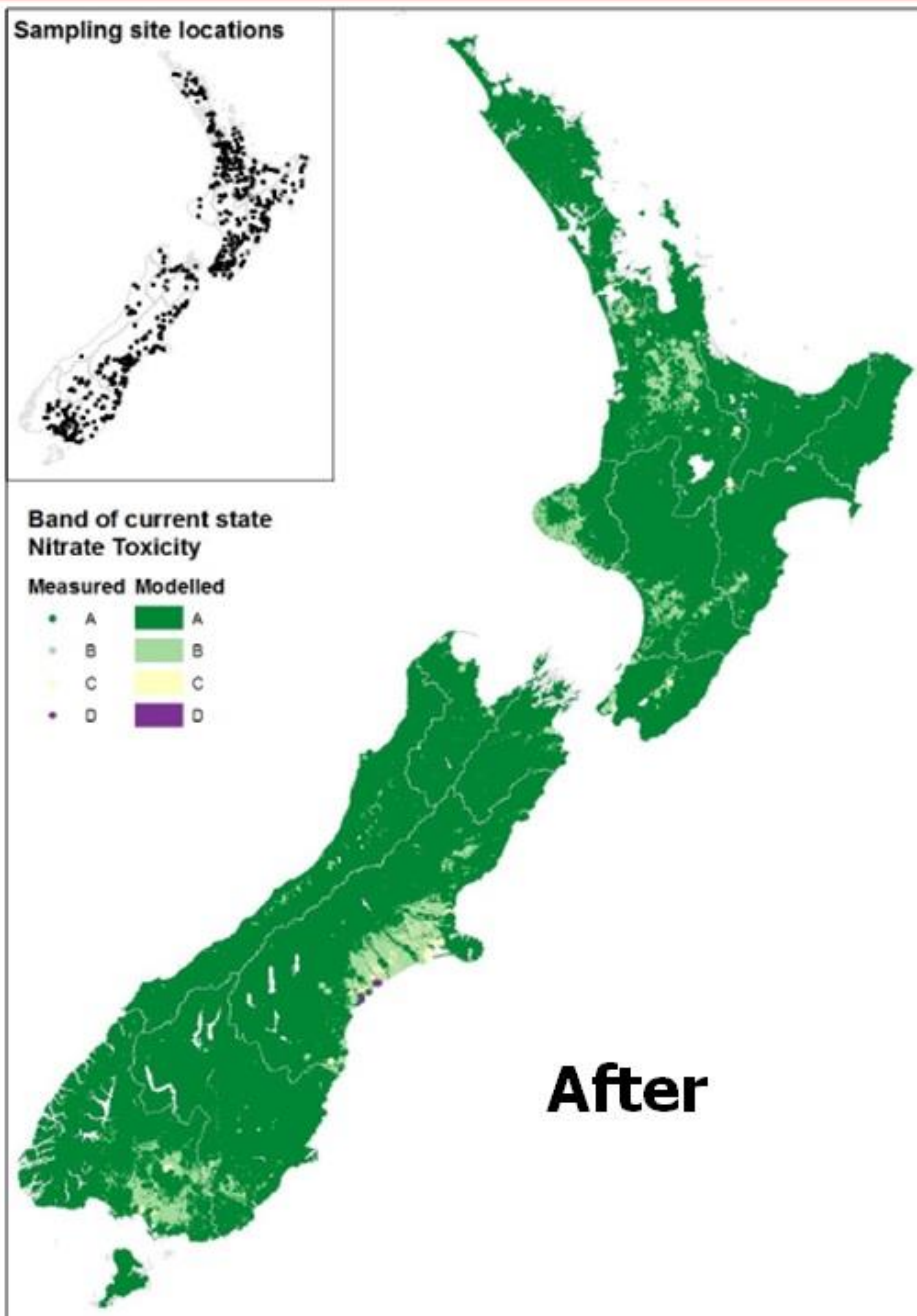



Ammonia

Dissolved oxygen - only point source

# "A fresh start for freshwater" NPS objectives 2014: (making the problem disappear)

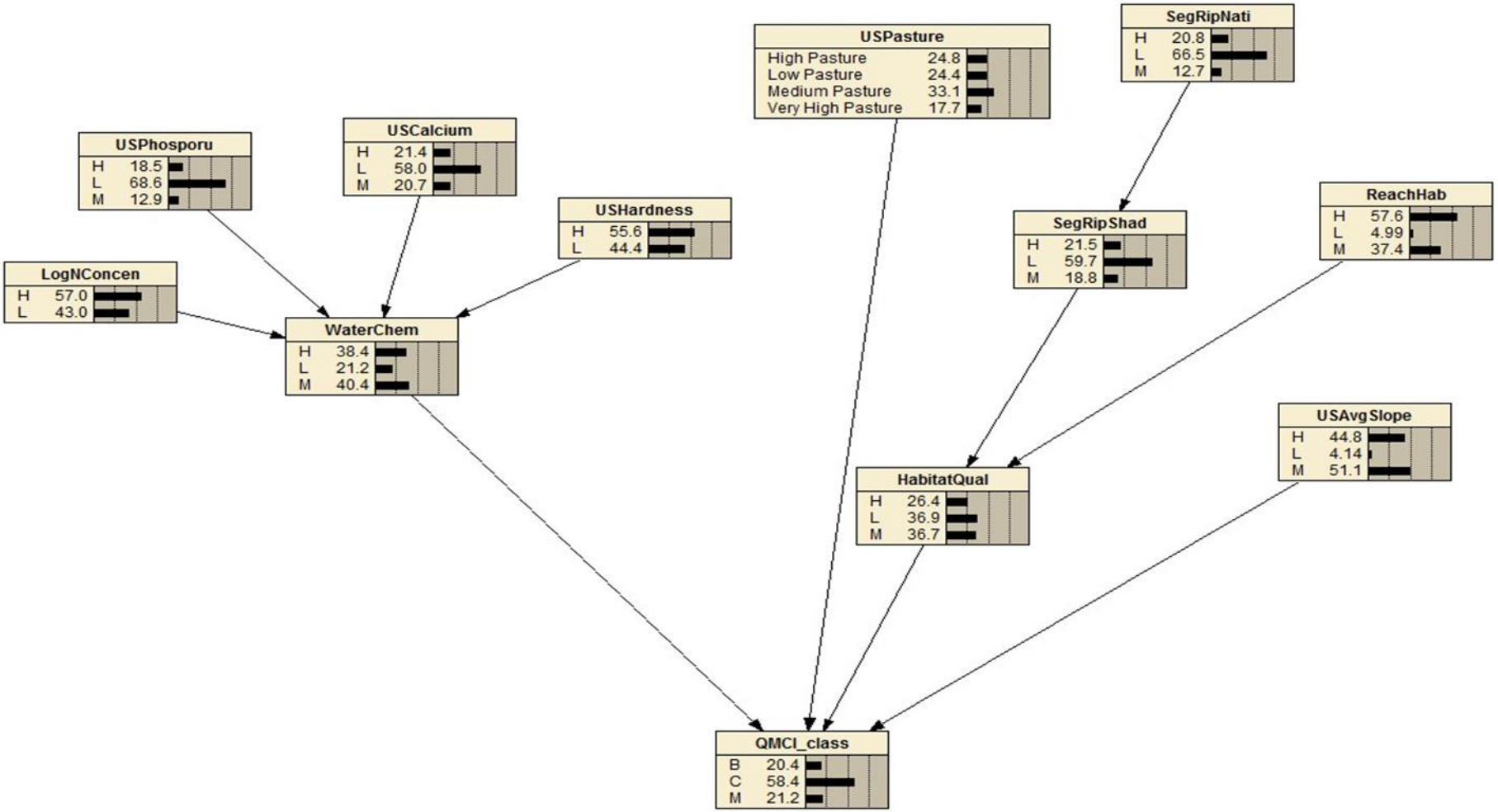


# Why is water quality bad?


# Ecology Decision Support Tools






Paparangi
Manawatu-Wanganui
Parikino
Mangamahu
Kaiwhaiki
Brunswick
Kai Iwi
Upokongaro
Westmere
Whanganui
Whanganui
Okoia
Kaitoke
Fordell
11.3 km
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# Poor health in New Zealand rivers?

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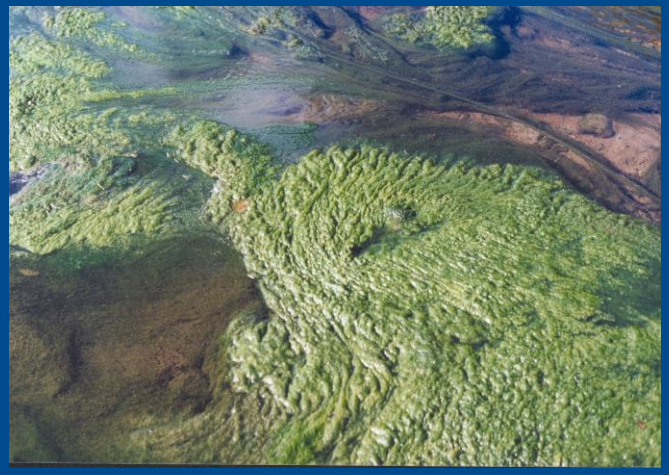
## Ecological health



## Human health

Cryptosporidium
*Giardia lamblia*
*Toxoplasma*
Cyclospora
Entamoeba

Hepatitis
Adenoviruses
Non-Group A
Rotaviruses
Caliciviruses

Vibrio (*cholerae, vulnificus*)
*Escherichia coli*
Faecal coliform
Shigella
*Helicobacter pylori*
Leptospira
Campylobacter
Yersinia enterocolitica
*Salmonella* (typhoid, paratyphoid)
*Clostridium*
*Mycobacterium*
Legionella

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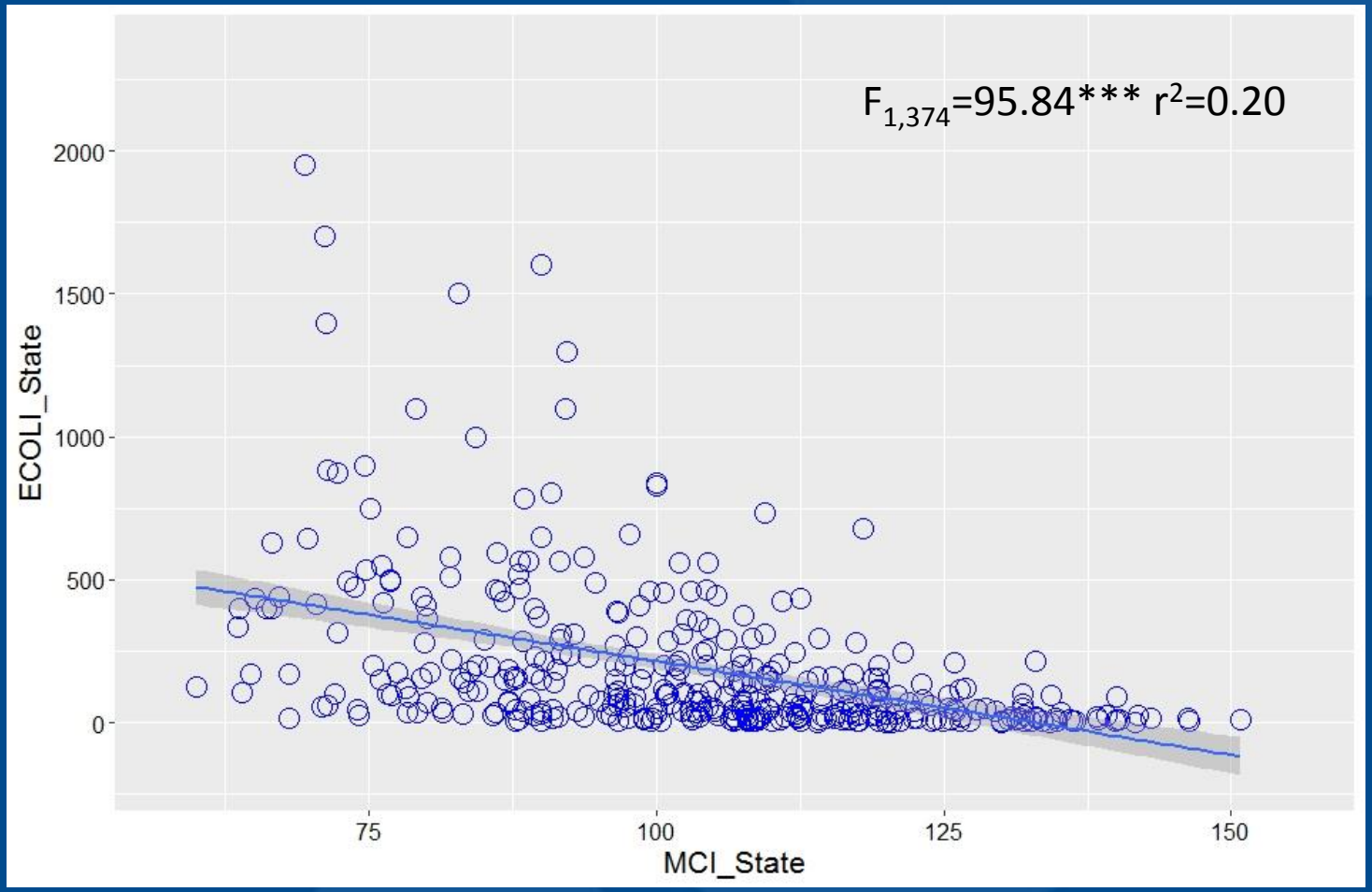
# Does ecological health = human health?




Human health ↓

Ecological health →

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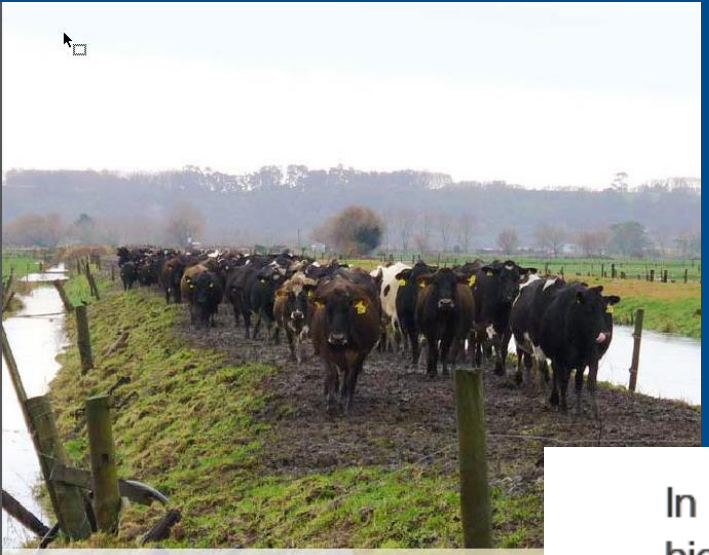


In New Zealand, infections from zoonoses "are among the highest reported for any developed country … and are a major public health concern" [16].

> **"Reported cases of cryptosporidiosis are higher in New Zealand than in Australia, the UK, Germany and the USA [17].**

The same is true for Shiga toxin-producing *E. coli* (a group of *E. coli* bacteria that cause infection in humans, also known as verocytotoxigenic *E. coli*) [18] and giardiasis [3].

# Agricultural industry solution

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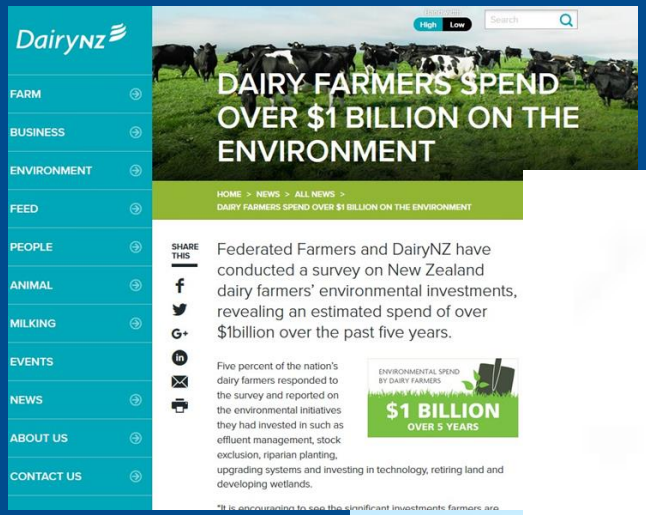


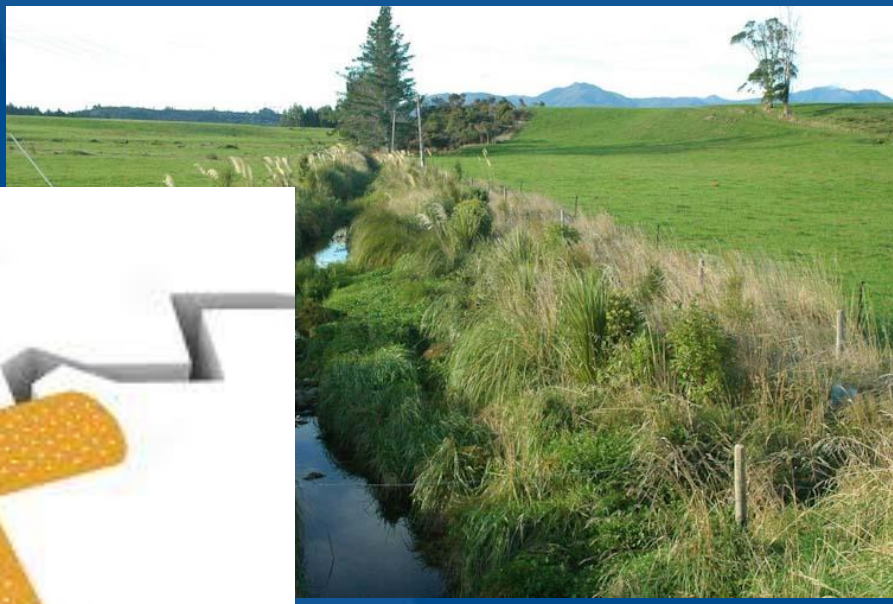

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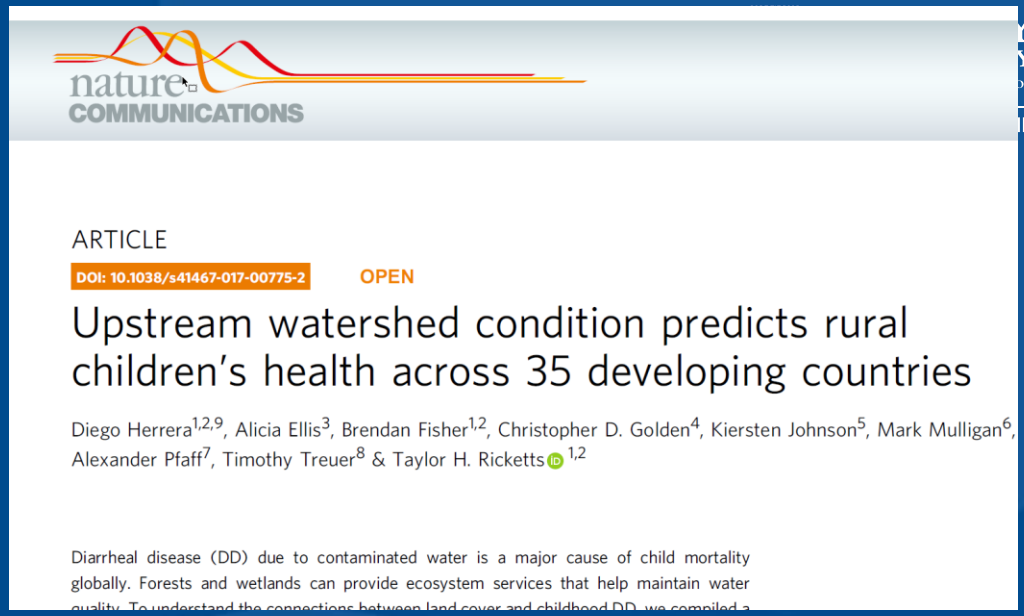
# Solution = One Health



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ARTICLE

DOI: 10.1038/s41467-017-00775-2 OPEN

## Upstream watershed condition predicts rural children's health across 35 developing countries

Diego Herrera[1,2,9], Alicia Ellis[3], Brendan Fisher[1,2], Christopher D. Golden[4], Kiersten Johnson[5], Mark Mulligan[6], Alexander Pfaff[7], Timothy Treuer[8] & Taylor H. Ricketts[1,2]

Diarrheal disease (DD) due to contaminated water is a major cause of child mortality globally. Forests and wetlands can provide ecosystem services that help maintain water quality. To understand the connections between land cover and childhood DD, we compiled a

- Do ecologists and microbiologists work together in a catchment management framework?
- Even the regulatory framework seems disjointed
- It also seems the solution framework is disjointed

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# Are unhealthy rivers bad for?

YES


Its also our economic edge?

Doesn’t it make financial sense to have healthy rivers?

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